Transitioning Technology to PM FCS

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Historically, the jump from 6.3 to 6.4 funding has been the most difficult for a new program. Numerous transition issues can contribute to this difficulty, but the maturity of technology at Milestone B (MS B) and its readiness to transition into development has frequently been a fundamental cause of cost, schedule or performance anomalies. The Technology Readiness Assessment (TRA) and its service-level feeder document, the Technical Maturity Assessment (TMA), are management tools designed to establish a new program's technical fitness prior to MS B approval and to identify high-risk critical technologies before significant developmental investment is made.

To this end, the Future Combat Systems (FCS) Increment I TMA was completed and the TRA was subsequently forwarded to, and approved by, the Office of Secretary of Defense's Director of Defense Research and Engineering. As supporting documentation for MS B, the TRA contributed to a successful milestone decision resulting in a $15 billion FCS program. The TMA was researched and completed by the FCS Science and Technology (S&T) Integrated Product Team (IPT) from April 2002 to March 2003.

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Chartered by the Deputy Assistant Secretary of the Army for Research and Technology and Program Manger (PM) FCS, the FCS S&T IPT was formed with key technical representatives from each of the major research and development centers and labs; the FCS Lead Systems Integrator (LSI); Defense Advanced Research Projects Agency; Army Materiel Systems Analysis Activity; Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology; and U.S. Army Training and Doctrine Comamnd (TRADOC), including the Unit of Action (UA) Maneuver Battle Lab (UAMBL). The IPT was co-chaired by Dr. James Bradas, Aviation and Missile Research, Development and Engineering Center (AMRDEC); and Edward Brady, Strategic Perspectives Inc. The first challenge faced by the IPT members was to answer these key questions:

- What process should be used by the IPT to evaluate FCS technologies?
- How should the critical technologies for the FCS System-of-Systems (SoS) be defined?
- What criteria/tools should be used to accurately and consistently determine technology maturity?
- What determines the technology program's readiness to transition into development?

Process

Figure 1 defines the process followed by the IPT. Early efforts focused on evaluating key technologies identified by the LSI during the proposal phase that were clearly needed to realize the UA requirements. The LSI had gone through a structured technology search and winnowing process starting with more than 3,000 technologies in May 2000 and ending with more than 700 technologies in June 2002. From these technologies, a key set of 40 and a super set of the 15 most important technologies were selected for initial IPT evaluation. The evaluation's result was to bin the technologies into Increment I or Increment II according to the technology maturity/readiness level.

Later, as the FCS Operational Requirements Document (ORD) emerged and key performance parameters (KPPs) were defined, the IPT established the critical technologies (CTs) definition. Applying that definition against available technologies produced source technologies required for Increment I FCS. The subsequent evaluation of these CTs was recorded in the TMA.

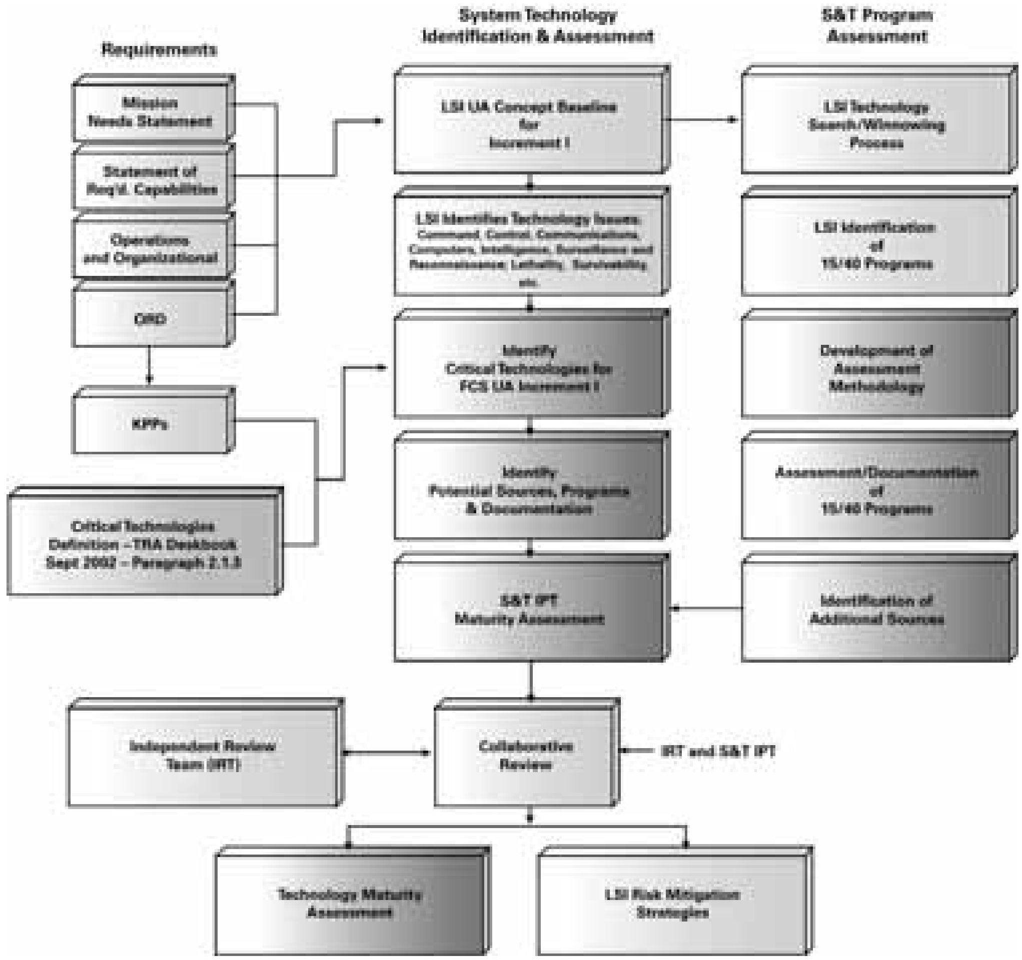

Figure 1. Technology Assessment Process

Definitions

There are a few key ingredients to a successful TMA — a clear definition of CTs, a comprehensive database of source technologies and solid criteria applied as objectively as possible to assess technology maturity. For the FCS S&T IPT, the CT definition was structured as follows:

- Technology must meet the FCS system operational requirements. If it doesn't meet the necessary criteria, UA effectiveness will be significantly degraded if technology is not available. Technology absence will result in significant impacts to the overall SoS concept.
- Technology, or its application, is either new or novel.

The CTs were generated by specifying the technology required to achieve the seven FCS KPPs. There are 31 CTs, for which there are 77 source technologies/programs. These were evaluated using several tools, primarily the technology readiness level (TRL), that apply to different aspects of technology maturity.

Tools

Although a primary technology assessment tool, the TRL, as defined in DoD 5000.2-R (for both hardware and software) is a necessary but insufficient measure of transition readiness for a technology program. These TRL definitions provide a structured standard to assess technologies. However, the IPT found that different S&T communities have different cultures and thought processes when addressing maturity of their particular type of technology, making TRL assessment standardization difficult.

One method for increasing objectivity is to group the table definitions into a spreadsheet using common parameters that are evaluated separately. The parameters used included hardware status, integration level, test/demonstration type, simulation/modeling and environment. As an example, using the parameter "environment," "laboratory" is TRL 4 or lower, "high-fidelity laboratory" is TRL 5, "simulated operational environment" is TRL 6 and "operational environment" is TRL 7 or higher. When examined in this manner, not all aspects of a technology program will achieve the same TRL, generating a fractional but more objective overall TRL. As useful as it is, however, the TRL does not measure

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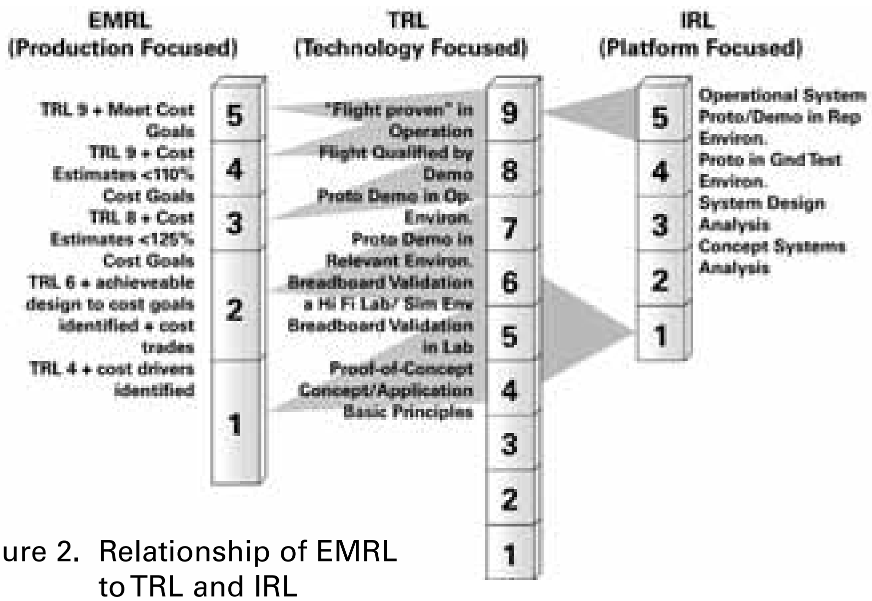

Figure 2. Relationship of EMRL to TRL and IRL

technology program integration readiness, interoperability or producibility.

The IPT found an assessment tool that does focus on producibility issues and shows promise as a check sheet to help coordinate the transition of technologies from S&T to system design and development (SDD). Known as the engineering manufacturing readiness level (EMRL), this detailed tool looks at design-to-cost, tooling and special test equipment and all aspects of design including systems engineering requirements and trade-off studies, processes, materials and facilities required. AMRDEC's Engineering Directorate at Redstone Arsenal, AL, has defined this metric tool with great precision and uses the tool to help PMs correct deficiencies in their program preparation before MS B. Designed to be used at the component level, the EMRL can also be used at the system level as an indicator of program maturity. Figure 2 depicts the relationship of the EMRL to the TRL and the integration readiness level (IRL).

The IRL has limited utility when assessing technology programs transitioning to SDD as TRL 6 corresponds to IRL 1. To achieve anything higher, the program would have to be in SDD and have completed a preliminary design review (PDR). Thus, the IPT did not attempt to establish any IRL ratings.

Technology Transition

IPT members looked at three technology transition types to better define readiness for transition into early SDD:

- An advanced technology demonstration, technology demonstration or advanced concept technology demonstration transitions directly into a specific program.
- A pre-planned product improvement.
- Technology maturation.

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Normally, the close association of the SDD PM required in Types 1 and 2 greatly improves the probability of good dialog and teamwork with the Science and Technology Objective Manager/Technology PM. However, few formal technology transition plans were uncovered during the IPT technology review. Technology transition coordination for Type 3 is more difficult because the SDD PM would normally be identified after the capability is put on the shelf. Here, transition would start after most of the early decisions had already been made concerning form, fit and function, thereby complicating the design, integration and test process.

It became evident during the IPT that more emphasis was needed to orient the S&T community toward transition issues to better streamline technology insertion. Currently, technology centers produce the technology but don't necessarily focus on *transitioning* that technology to other programs. Steps that could help correct this oversight include:

- Requiring early coordination between Technology PMs and SDD PMs to include collaboration on program risks, execution plans, transition plans, integration issues and test/demonstration schedules.
- Establishing formal memorandums of agreement to define responsibilities for all including the Technology PM, SDD PM, user and contractor.
- Performing detailed joint examinations of technology maturity using the aforementioned management tools to reduce the probability of expensive surprises once the program transitions into SDD.
- Blocking schedules into increments based on technology maturity and planning for insertion of less mature technology in later blocks.

A detailed "how-to" handbook to guide the Technology PM and SDD PM Team would go a long way to facilitating these goals. However, *A Manager's Guide to Technology Transition In an Evolutionary Acquisition Environment: A Contact Sport* (August 2002) is an excellent interim publication that can be used now.

The FCS S&T IPT took a detailed look at the state of technology available to realize the Army's desired future combat capabilities and recorded the CTs required and their maturity levels in the TMA. Bottom line: the necessary technology for Increment I exists and will transition, but not without risk. Transitioning that technology from the technology base into development will be a complicated but achievable task that will help transform our Army for the future. A key lesson learned by the FCS S&T IPT is that the S&T community needs to begin to pay as much attention to *transitioning* their technology as they are in making the technology work. To this end, coordination and cooperation between the Technology PM and future project/product managers, users and contractors is crucial to prepare programs for success. Excellent assessment tools are available to provide managers the metrics they need to plan and execute programs. In short, what gets measured gets done.

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RAVEN — New Gun Shakes up FCS

Dr. Eric Kathe, Henry Nagamatsu and Joseph Flaherty

Packing lots of punch in small packages is a succinct description of the armament requirements for Future Combat Systems. During the past 3 years, a new gun propulsion method has been discovered, analyzed, patented and fired that may usher in a new era of lightweight weaponry. Termed RAVEN for RArefaction waVE guN, it achieves this by decimating the core engineering challenges to lightweight gun integration — recoil and thermal management.

The RAVEN Principle

If the breech of a gun's chamber is suddenly opened while the bullet is being propelled through the bore, a delay time will occur before the pressure loss in the chamber can be communicated forward to the bullet's base. Thus, it is possible to trick the bullet into thinking it is being fired from a closed breech gun when it is not.

How RAVEN Works

When the breech is vented, the pressure in the chamber plummets. This pressure loss propagates through the